Chapter 4. Water Quality

4.1 Introduction and Methodology

Chapter Contents

A substantial part of the assessment effort conducted for this report involved compiling and analyzing the available data on water quality throughout the watershed. Especially in some portions of the watershed, significant monitoring work has been done over the past 30+ years. This monitoring was performed for a variety of purposes, and has never been compiled in a way that would facilitate comparing water quality across sites and over time. For this assessment, we compiled all the water quality sources we could locate that represent more than isolated one-time studies. Data were subject to QA/QC review, and organized by location of sampling sites. An initial analysis of this database provided the basis for this assessment report. The database will prove very valuable in the future, as well, to support more detailed studies of particular pollutants and locations. The location of sites for which sampling data were compiled are shown in Figures 2-2 through 2-10.

Data were compiled from studies by the following parties over the period 1967 through 2002:

- United States Environmental Protection Agency – STORET Program
- United States Geological Survey (USGS)
- USGS National Ambient Water Quality Assessment (NAWQA) Program
- Massachusetts Water Resources Authority (MWRA)
- Massachusetts Department of Environmental Protection (MADEP)
- Massachusetts Water Resources Commission (MWRC)
- Metropolitan District Commission (MDC)
- Mystic Monitoring Network (MyRWA)
- Tufts University

Appendix B provides a more detailed discussion of the sources used, the sampling locations, and steps taken to create the database. Appendix C provides detailed results that support the summary data reported in this chapter for each subbasin.

4.2 Overview of Results

Ambient Water Quality

We assessed the watershed's water quality by comparing monitoring results with the state's water quality standards for specific pollutants and, where there are no numerical standards, with other guidelines. These standards and guidelines are listed in Table 4.1a.

Table 4.1a: Water Quality Standards for Class B Waters and Other Guidelines

Parameter	Criteria Denoting a Violation	Source
Dissolved Oxygen	Less than 5.0 mg/L Saturation less than 60%	Massachusetts Water Quality Standards 314 CMR 4.00
Temperature	Greater than 28.3 C	Massachusetts Water Quality Standards 314 CMR 4.00
pH	Below 6.5 or above 8.3	Massachusetts Water Quality Standards 314 CMR 4.00
Fecal Coliform	Geometric mean greater than 200 colonies per 100 mL or more than 10% of samples greater than 400 cfu/mL	Massachusetts Water Quality Standards 314 CMR 4.00
Enterococcus	Geometric Mean (5 samples over 30 days) greater than 33 colonies per 100 mL	Massachusetts Minimum Standards for Bathing Beaches State Sanitary Code 105 CMR 445.000
E. Coli	Geometric Mean (5 samples over 30 days) greater than 126 colonies per 100 mL	Massachusetts Minimum Standards for Bathing Beaches State Sanitary Code 105 CMR 445.000
Total Nitrogen	Greater than or equal to 0.30 mg/L (0.15 mg/L in lakes)	Massachusetts Water Watch Partnership Data Interpretation Manual
Total Phosphorus	Greater than or equal to 0.05 mg/L (0.025 mg/L in lakes)	Massachusetts Water Watch Partnership Data Interpretation Manual
Total Suspended Solids	Greater than 10.0 mg/L (guideline for aquatic life)	Massachusetts Water Watch Partnership Data Interpretation Manual

Massachusetts Department of Environmental Protection (May 12, 2000). *Massachusetts Water Quality Standards 314 CMR 4.00*.
Schoen, J. and Walk, M. (June 2002). *Data Interpretation Manual*, Massachusetts Water Watch Partnership, Amherst, MA.
Massachusetts Department of Environmental Protection. *Massachusetts Minimum Standards for Bathing Beaches State Sanitary Code 105 CMR 445.000.*

It is important to note that the guidelines used for nitrogen, phosphorus and TSS are not official state water quality standards, but rather have been suggested as a benchmark by the Massachusetts Water Watch Partnership for volunteer water quality monitoring programs.

As might be expected in a watershed with the Mystic's history and current urban land use, many of the waterbodies frequently do not meet the standards for their designated uses or that exceed the other guidelines used in this report. Table 4.1b shows the Mystic waterbodies that are currently listed as impaired on the Massachusetts Integrated Waters List[4], along with the pollutants causing the impairments.

Table 4.1b: Waterbodies on the Massachusetts Year 2004 Integrated List of Waters (Category 5 – Section 303(d))

Subbasin	Waterbody	Segment #	Class[1]	Causes of Impairment[4]
Aberjona River	Aberjona River (7138350)	MA71-01	Class B (WW, CSO)	metals, NH_3, nutrients, organic enrichment/low DO, *other habitat alterations*, pathogens

[4] Table 5 of the Integrated Waters List – list the waters that are impaired (i.e. do not support uses) – is often referred to as the 303(d) List, based on the Clean Water Act section that requires states to identify impaired waters.

Table 4.1b: Waterbodies on the Massachusetts Year 2004 Integrated List of Waters (Category 5 – Section 303(d))				
Subbasin	**Waterbody**	**Segment #**	**Class[1]**	**Causes of Impairment[4]**
	Judkins Pond (71021)	MA71-021		nutrients, organic enrichment/low DO, pathogens
Alewife Brook	Alewife Brook (7138250)	MA71-04	Variance (WW)	metals, nutrients, organic enrichment/low DO, pathogens, oil & grease, taste, odor & color, *objectionable deposits*
	Spy Pond (71040)	MA71-040		Pesticides, nutrients, organic enrichment/low DO, noxious aquatic plants, *exotic species*
	Clay Pit Pond (71011)	MA71-011		Pesticides
	Blacks Nook (71005)	MA71-005		Nutrients, noxious aquatic plants
	Winn Brook (7138280)	MA71-09		(proposed for 2006: pathogens)
Chelsea Creek	Chelsea River (Chelsea Creek) (7138100)	MA71-06	Class SB (CSO)	Prioritized organics, NH_3, organic enrichment/low DO, pathogens, oil & grease, taste, odor & color, turbidity, *objectionable deposits*
	Mill Creek (7138125)	MA71-08		pathogens
Horn Pond	Horn Pond (71019)	MA71-019	Class B (WW)	nutrients, organic enrichment/low DO, noxious aquatic plants
	Wedge Pond (71045)	MA71-045		nutrients, noxious aquatic plants
	Winter Pond (71047)	MA71-047		Nutrients, noxious aquatic plants, turbidity
Malden River	Malden River (7138200)	MA71-05	Class B (WW)	organic enrichment/low DO, pathogens, oil & grease, taste, odor & color, suspended solids, *objectionable deposits*
	Ell Pond (71014)	MA71-014		Nutrients, pathogens, suspended solids
Mill Brook	Mill Brook (7138300)	MA71-07		Pathogens, *objectionable deposits (proposed 2006: other habitat alterations)*
Mystic Lakes	Lower Mystic Lake (71027)	MA71-027	Class B (WW) (CSO)	Organic enrichment/low DO, salinity/TDS/chlorides
Mystic River 1[2]	Mystic River (7138150)	MA71-02	Variance	metals, nutrients, pathogens
	Bellevue Pond	MA71-004		noxious aquatic plants
Mystic River 2[3]	Mystic River (7138150)	MA71-03	Class SB (CSO)	Priority organics, metals, NH_3, other inorganics, organic enrichment/low DO, pathogens, oil & grease, taste, odor & color

Table 4.1b: Waterbodies on the Massachusetts Year 2004 Integrated List of Waters (Category 5 – Section 303(d))

Subbasin	Waterbody	Segment #	Class[1]	Causes of Impairment[4]

[1]Restrictions (shown in parentheses) may affect how water quality criteria are applied under 314 CMR 4.00. WW = warm water fishery, which indicates that dissolved oxygen and temperature criteria for warm water fisheries apply; CSO = combined sewer overflow, which indicates waters are impacted by the discharge of sewage mixed with stormwater.
[2]Mystic River 1 is from the outlet of Lower Mystic Lake to the Amelia Earhart Dam.
[3]Mystic River 2 is from the Amelia Earhart Dam to the confluence with the Charles River in Boston Harbor.
[4]Sources shown in italics are not pollutants, and therefore do not require a TMDL.

In addition, many waterbodies in the Mystic River Watershed have not yet been assessed by MA DEP for their compliance with water quality standards. The 2004 and proposed 2006 Integrated Waters Lists identify two waterbodies in the Mystic River Watershed as “not assessed”: Bellevue Pond in Medford and Hills Pond in Arlington. MyRWA has requested that a number of other waterbodies be included in the final 2006 Integrated Waters List as “not assessed”, and has requested that all unassessed waterbodies in the watershed be assessed for future Integrated Waters Lists.[5]

Analysis of the available water quality data and other evidence suggests that additional listings of waters are appropriate. MA DEP has proposed some additional listings for the 2006 as noted in Table 4.2.

In addition, MyRWA has requested that Mill Brook, Malden River, Winn Brook, Meetinghouse Brook (Medford) be listed as impaired for nutrients, and that Wellington Brook, Cummings Brook (Woburn), Little Brook (Woburn), Meetinghouse Brook (Medford), Sales Creek (Revere), Shaker Glen Brook, Sickle Brook (Lexington) and Whipple Brook be listed as impaired for pathogens. MA DEP does not list waterbodies as impaired for nutrients based solely on monitored concentrations of nutrients, since there are no numerical water quality standards for nutrients. Evidence of “eutrophic conditions, such as wide ranges in dissolved oxygen concentrations, elevated chlorophyll values, or biological surveys (in combination with nutrient concentrations) that reveal algae or plant “bloom” conditions that result in one or more impaired uses” is needed to add waters to the 303(d) list. More work is needed using these criteria in waterbodies where there is evidence of elevated nutrient levels to determine whether listings for nutrient impairments are therefore needed.

The most common pollutants identified as impairing waters in the Mystic are pathogens, nutrients, and organic enrichment/low dissolved oxygen (DO), which are causing water quality impacts to approximately 21 river miles and 369 lake acres within the watershed (MA 2004 Integrated List of Waters-Category 5). Toxic metals and organics in the water column have not been assessed extensively, with some exceptions. Waters in the lower part of the watershed (the Mystic River 2 and Chelsea Creek subbasins) are also listed for oil & grease, odor & color, and

[5] The additional waterbodies that MyRWA believes should be included in the Integrated Waters List include: Upper Mystic Lake, Wellington Brook, Meetinghouse Brook, Cummings Brook, Shaker Glen Brook, Sickle Brook, Whipple Brook, Horn Pond Brook, Island End River, Sales Creek, and Spot Pond.

turbidity, which suggests a more complex “soup” of pollutants than found elsewhere in the watershed.

The analysis of the sampling data reported in this chapter identifies the number of samples that exceed the MA water quality standard for a particular parameter (or other criterion, where a standard is not available). It is important to note, however, that the analysis reports number of individual samples exceeding specific levels for bacteria, although the water quality standards are based on the comparing the geometric means of a group of samples with those levels. The tables should be interpreted as reporting the number of exceedances of a certain level (the standard for each pollutant) but not as the number of formal exceedances of MA water quality standards.

Despite the large number of samples taken in the watershed between 1967 and 2002, it is difficult to discern significant long-term trends in water quality. To assess trends over time, we compared samples exceeding relevant water quality standards or other guidelines between the period 1967-1997 and the period 1998 – 2002. There were only a few cases where sufficient samples had been taken during both time periods at the same sampling sites to provide reasonable evidence of trends. Where there was sufficient consistency in sampling locations across the two periods, there were only a few locations where major trends were observed. Cases where trends were evident are discussed in the sections on each subwatershed, below.

Much more work is needed to analyze the available water quality data. For example, comparing sampling sites located close to each other, though not in identical locations, may provide additional insight into water quality trends. In addition, trends may be evident over shorter time horizons than evaluated here. Finally, the Mystic River Watershed Association’s (MyRWA’s) monthly baseline monitoring data at 10 sites, begun in 2000, will soon have enough sample observations to begin use for trend analysis. These MyRWA data have not yet been assessed for trends, since meaningful trend analysis will require enough observations to allow controlling for the effects of precipitation. An analysis of trends using the MyRWA data is planned for 2006.

Sediment Quality

USGS recently completed an evaluation of sediment quality in a substantial portion of the Mystic River Watershed. Appendix G provides an overview of the study results. Other specific studies of sediment quality are discussed in the section on each subbasin below. Now that the USGS results are available, a systematic review of sediment quality is needed to assess impacts and identify priorities for potential remediation.

Pollution Sources

Substantial work is still needed to identify sources of water quality problems in the Mystic watershed. To some extent, the sources are associated with urban land use in general, and the actions required to address these sources involve general stormwater and wastewater management programs. These include the Phase I and II stormwater programs, and outreach and education to encourage good stewardship by local residents and small businesses (proper disposal of used oil, reduced fertilizer and pesticide use, reduced littering and dumping, etc.). In other cases, pollution may be a legacy of past practices and come from contaminated sediments or from migration of pollutants from contaminated sites. Finally, there may be specific sources of pollution from industrial and transportation facilities and construction sites that must be addressed by facility-specific inspections and enforcement. This pollution might come from inadequate stormwater management, spills and leaks of oil and hazardous materials, or direct illegal discharge of pollutants to the water or to sewers. Some of these varied sources have been well-characterized in the Mystic River Watershed, but in many cases there is little information on whether specific sources are degrading water quality. A more comprehensive inventory of practices, sites and facilities that might be polluting the waters is therefore a high priority for the Action Plan.

Bacteria Sources

The most important current pollutant source throughout the watershed is likely to be general urban runoff and sewage discharges from Combined Sewer Overflows (CSOs) and inadequate stormwater and sanitary sewer systems.

CSOs are permitted for the following sources: Boston Water & Sewer (Chelsea Creek & Mystic River), Cambridge (Alewife Brook), Chelsea (Chelsea Creek & Mystic River), the Massachusetts Water Resources Authority (MWRA) (Mystic River, Alewife Brook), Somerville (Mystic River & Alewife Brook).

The MWRA and the CSO municipalities are working on a Long Term Facilities Control Plan to reduce the number and size of CSOs. Monitoring and evaluation of options for further reducing CSO contributions to bacteria pollution is continuing under a water quality variance for Alewife Brook and the Mystic River.

There are also substantial numbers of Sanitary Sewer Overflows (SSOs) and illegal connections that contribute bacteria loads to receiving waters throughout the watershed. These sources are the target of Section 308 information requests and Notices of Noncompliance issued to a number of Mystic municipalities (see Appendix F.) Further work is needed to determine whether additional Section 308 notices are warranted for SSOs and violations of Stormwater Permits for industrial sources and properties owned by the DCR, Mass Highway, and MassPort.

A substantial portion of the total wastewater flow to MWRA's Deer Island Treatment plant consists of groundwater infiltration and stormwater inflow.[6] This infiltration and inflow (I/I) required that the entire wastewater treatment system (pipes and Deer Island treatment facility) be much larger than required to sanitary flow alone. In addition, I/I contributes to the large seasonal fluctuations in wastewater flow, and contributes to local sewer back-ups, sanitary sewer overflows, and more frequent combined sewer overflows. Infiltration also reduces flows in the rivers. MWRA estimates that infiltration of groundwater and stormwater inflow represent 43% and 15% of the typical year wastewater flow, respectively. In the highest recent flow month (April 1997), infiltration was 57% and inflow was 18% of total flow.

A variety of problems in the extensive wastewater system can contribute to I/I, including leaks in pipes, discharge of sump pump flow into the sewers, and ponded stormwater pouring in through manholes. MWRA is implementing a pipeline rehabilitation process for its own interceptor

[6] The following information on I/I to the MWRA system was provided in a 2006 briefing by Carl Leone to the MWRA Wastewater Advisory Committee.

pipes, to reduce these problems. TV inspection has been completed for all interceptor pipes, and priorities have been established for repair. Five projects are now underway for pipes sections located in Arlington, Lexington, Winchester and Medford, and addition work is being evaluated in Winchester.

Funding and technical support is also provided by the MWRA's Community Support Program to its member sewer communities to support I/I reduction work. The goal is to minimize public health impacts from local sewer back-ups and sanitary sewer overflows (SSOs). Metering data compiled by the MWRA has been used to prepare annual estimates of inflow and infiltration as a percent of average daily flow, as shown in Table 4-2. (This table also shows the number of miles of local sewers, the estimated average daily flow, and the percent of available I/I reduction funding from MWRA that had been used by each community as of August 2006.) The last full I/I report was for Calendar Year 2003, and has not been published for the last two years as MWRA has been in the process of upgrading its metering system. The new meters are expected to provide more reliable data on flows, both as a basis for setting rates and as a measure of the components of flow. When these data are again available, for Calendar Year 2006 and after, they should be reviewed to track progress by Mystic communities in reducing I/I and to target funding for additional efforts.

Table 4-2: CY 2003 MWRA Community Estimated I&I and Funding Use

	Sewered Population	Miles of Local Sewers	Av Daily Flow (MGD)	Infiltration as % ADF	Inflow as % ADF	Percent of Available Funding Used**
Arlington	42,098	106	6.30	48.3	10.3	47
Belmont	23,540	78	3.91	50.6	12.8	51
Boston (BWSC)*	588,692	840	104.59	32.8	17.3	55
Burlington	22,510	115	3.99	57.9	6.5	82
Cambridge*	101,705	150	17.45	33.9	18.2	59
Chelsea*	34,913	41	3.99	16.5	26.3	82
Everett	37,734	57	6.29	50.9	10.5	82
Lexington	29,130	151	6.68	55.4	7.8	44
Malden	56,099	99	9.12	56.4	10.5	57
Medford	55,082	113	9.37	46.7	11.7	82
Melrose	26,936	74	5.07	46.9	19.7	62
Reading	22,330	86	2.97	41.1	8.4	82
Revere	47,449	78	7.27	48.7	16.8	53
Somerville*	76,845	107	10.26	39.2	25.1	53
Stoneham	21,700	63	3.65	37.3	9.3	83
Wakefield	23,757	82	4.86	55.1	10.1	75
Watertown	32,857	75	4.14	40.8	8.9	31
Wilmington	3,699	19	1.54	37.7	3.9	82
Winchester	21,072	83	3.09	47.2	11.7	46
Winthrop	18,235	36	2.06	47.1	11.7	32
Woburn	36,103	141	10.8	50.6	10.6	81

Table 4-2: CY 2003 MWRA Community Estimated I&I and Funding Use

	Sewered Population	Miles of Local Sewers	Av Daily Flow (MGD)	Infiltration as % ADF	Inflow as % ADF	Percent of Available Funding Used**

Source: Attachment 6 to MWRA Annual I/I Reduction Report for FY 2004. Flow data for CY03.
* Community with combined sewer overflows. Inflow figures include combined flow during storm events tributary to MWRA's wastewater treatment plan.
**Funding used through August 2006 from www.mwra.state.ma.us/comsupport/iisummary.pdf

Hazardous Waste Sites

There are also a large number of hazardous waste sites throughout the watershed, as shown in Appendix D. These hazardous waste sites are generally not believed to be significant current contributors to water quality problems, although there are some notable exceptions. For example, the old coal gasification site on the Island End River is still discharging pollutants into the river. Appendix E lists the facilities holding NPDES permits to discharge directly into surface waters. Appendix F lists specific pipes that have been cited by EPA and DEP under their §308 actions against six municipalities, requiring investigation and remediation of defective sewers and illegal connections that contribute to bacteria loadings. The sources listed in these appendices should be investigated as possible sources of current pollutant loadings, as part of TMDL development throughout the watershed. The location of hazardous waste sites and CSOs are noted on the maps shown in Chapter 2 (Figures 2-2 through 2-10).

Boating

Extensive boating activity throughout the watershed is likely to be a source of pollutants, although there has not been any assessment of the contribution of boating to water quality problems. Discharges of boat sewage can contain pathogens, nutrients and chemical compounds that degrade water quality and adversely affect aquatic life. There is substantial recreational and commercial boating use of the Mystic, and improved management of boat sewage could have a significant impact on localized water quality problems.

A cooperative effort of state and federal agencies and municipalities recently resulted in the designation of selected South Shore waters as No Discharge Areas, which prohibits all discharge of boat sewage. An adequate number of boat pump-out facilities must be in place before EPA will approve a NDA. Currently, EPA's NDA Strategy for New England does not envision any NDA designations for much of the Massachusetts coastline over the next five years, however, in contrast with plans that cover much or all of the Connecticut, Rhode Island, New Hampshire and Maine coasts.

Currently there are pumpout facilities at a number of locations in Boston Harbor and the Lower Mystic, including at the Admiral's Hill Marina in Chelsea, Mystic Marine, and Constitution Marina (CZM 2006). Investigation is needed to assess whether the available pump-out capacity is sufficient based on EPA's criteria, and to determine whether the Boston Inner Harbor and its tributaries should be considered for a NDA designation.

As reported by MA Coastal Zone Management, conventional carbureted 2-stroke outboard motorboat engines allow as much as 20-30 percent of the fuel used to pass directly to the air or water, releasing toxic and carcinogenic materials to the environment. U.S. EPA developed regulations in 1996 that will result in a 75 percent reduction of hydrocarbon emissions by 2025 from spark-ignition gasoline marine engines (including outboard engines, Personal Watercraft engines, and jet boat engines). These regulations will result in cleaner 4-stroke and Direct Fuel Injection 2-stroke engines, which should reduce releases to the waters as well. However, careful handling of oil and fuel and other best practices by boaters are also needed to ensure that their activities do not contribute to water quality problems.

Investigation is needed to assess current boating community waste management and compliance with best practices to prevent marine engine oil pollution, as well as sewage discharges. The Massachusetts Coastal Zone Management Office has published a Clean Marina Guide http://www.mass.gov/czm/marinas/guide/macleanmarinaguide.htm and provides information on environmentally-friendly boat engines http://www.mass.gov/czm/boatenginesfs.htm. These resources provide the basis for an outreach and education effort that would encourage stewardship of the waters by the boating community.

Port Activities

Port activities can also be a significant source of pollution, both of air (due to diesel emissions) and of water. U.S. EPA's Sector Studies program included a review of the environmental impacts of ports, and methods to reduce those impacts.[7] These included stormwater management, control of invasive species in ballast water, and the management of dredge materials. An evaluation of the management practices of port facilities in the Mystic River Watershed is needed to determine whether potential impacts are being adequately managed.

The assessment in this chapter focuses on chemical and biological characteristics of water quality. Many of the waterbodies in the Mystic are degraded with trash, including tires, shopping carts and general litter. The Action Plan recommends efforts to address these problems as well, which affect the recreational and aesthetic values of the area's waters.

4.3 Results and Priorities for Action by Subbasin

4.3.1 Aberjona River Subbasin

Pollutant Sources

The Aberjona River and Judkins Pond in Winchester center are both on the §303d list of impaired waterways (Table 4-2). Both are listed for organic enrichment/low dissolved oxygen and pathogens. Judkins Pond is also listed for nutrients, and the Aberjona is also listed for unionized ammonia (NH_3). Other known sources of pollution in the watershed include wastewater discharges and hazardous waste disposal sites. There are 15 wastewater dischargers in the subbasin; of these, three are unpermitted and one is a major discharger, Olin Chemical in Wilmington, which dischargers to a tributary of the Aberjona.

[7] http://www.epa.gov/sectors/ports/index.html. See also EPA Office of Compliance, 1997.

Between the 1860s and the 1980s, the Aberjona subbasin was home to several chemical-intensive industries, including chemical manufacturing and leather tanning. The history of these industries has been well documented in the literature (e.g., Aurilio et al., 1995; Durant et al., 1990; Tarr, 1986). A significant chemical legacy remains from these industries and there are now many sites on the watershed that are contaminated with hazardous wastes. Two sites – IndustriPlex and Wells G&H – were so grossly contaminated that they are on the National Priorities List of sites eligible for funding under CERCLA (aka "Superfund"). The chemicals of concern at IndustriPlex included arsenic, chromium, and lead in the soil and plumes of toluene, benzene and dissolved arsenic in the groundwater.[8] Davis et al. (1994) reported that there has been significant offsite migration of arsenic and that a large amount of arsenic is accumulating in the sediments of Halls Brook Holding Area Pond, just south of the IndustriPlex site. The Wells G&H site is contaminated with trichloroethane, tetrachloroethane and other chlorinated solvents. In addition to the two Superfund sites, the state has identified 31 other sites in the subbasin where hazardous chemicals have been released (see Appendix D).

Water Quality Assessment

Table 4.3: Summary of Aberjona Water Quality Results

Parameter	Standard	1967-1997 (20 sites)		1998-2002 (4 sites)		Total Period 1967-2002 (20 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
Fecal coliform	Class B Geo mean >200 cfu/100 ML	279	45%	109	86%	388	56%
Fecal coliform	Class C Geo mean > 1000 cfu/100 ML	279	16%	109	38%	388	22%
Enterococcus	Geo mean >33 cfu/ML	0	-	56	100%	56	100%
E. Coli	Geo mean >126 cfu/100ML	0	-	18	100%	18	100%
Dissolved Oxygen	<5 mg/L	299	8%	59	7%	358	8%
Dissolved Oxygen Saturation	<60+ %	316	4%	39	13%	355	5%
Dissolved Oxygen Sat. Calculated	<60%	9	40%	94	18%	103	20%
Temperature	>28.3^{o}C	298	0%	57	0%	355	0%

[8]http://www.epa.gov/region01/superfund/sites/industriplex/, accessed May 2003.

Table 4.3: Summary of Aberjona Water Quality Results

Parameter	Standard	1967-1997 (20 sites)		1998-2002 (4 sites)		Total Period 1967-2002 (20 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
pH	<6.5 or >8.3	357	8%	59	0%	416	7%
Total Suspended Solids (TSS)	>10 mg/L	0	-	39	5%	39	5%
Total Nitrogen	>0.3 mg/L	0	-	112	100%	112	100%
Total Phosphorous	>0.05 mg/L	373	71%	141	36%	514	61%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

A significant amount of water quality data exists for the Aberjona subbasin. In addition to studies done in conjunction with the cleanup of the two Superfund sites, EPA recently investigated a ten-kilometer section of the Aberjona for hazardous chemicals that have been transported downstream from the Superfund sites (Metcalf & Eddy, 2002). Also, in the last ten years Prof. Harold Hemond and his students at MIT have performed several chemical-specific fate and transport studies on the river. These studies have greatly expanded knowledge of the importance of the river in transporting chemicals (e.g., toxic metals) to Upper Mystic Lake into which the Aberjona discharges. A third significant source of water quality data is the United States Geological Survey. Since the 1930s, the USGS has maintained a flow gauging site on the river just south of Winchester center. For the last five years, the USGS has monitored this site for nutrients, pesticides, and volatile organic compounds under its National Ambient Water Quality Assessment (NAWQA) program (http://water.usgs.gov/; accessed May 2003).

Overall, a total of twenty sites in the Aberjona subbasin were monitored at least once during the period 1967 through 2002. The data show that a relatively high percentage of samples contained elevated levels of bacteria and nitrogen. In addition, a very high percentage of the samples exceeded the guideline level for used in this report for total phosphorus (0.05 mg/L).

As shown in Table 4-3, far fewer sites have been routinely monitored in the subbasin over the last five years than during earlier years. Table 4-3 also suggests that water quality over last five years has not significantly changed compared with the earlier period. In fact, a higher percentage of samples show exceedances for bacteria in recent years, although there has been a decline in the percentage of Total Phosphorous exceedances.

Sediment Quality

Although several studies have been done to characterize sediment quality in the Aberjona subbasin, the data from those studies have yet to be combined and analyzed as a whole. The most comprehensive study, in terms of chemicals analyzed and river-kilometers assessed, was recently completed by the EPA (Metcalf & Eddy, 2002). In this study, over 200 sediment samples from the river and wetland areas were analyzed for priority elements and organic compounds[9]. Previously, Knox (1991) analyzed sediment samples from over 100 sites for the presence of toxic elements (e.g., arsenic, chromium, lead, cadmium, copper, and zinc). Also, Davis et al (1994) report that there has been significant accumulation of arsenic, chromium, lead and other toxic elements in the sediments of Halls Brook Holding Area Pond, and Spliethoff and Hemond (1996) report similar findings for Upper Mystic Lake. Based on these studies, the picture that has emerged is that sediments near chemical disposal sites (e.g., Halls Brook Holding Area Pond), in depositional areas along the river (e.g., the Wells G&H wetland), and Upper Mystic Lake are grossly contaminated with toxic elements. The major transport mechanism for the elements appears to be transport of contaminated sediments from erosional to depositional areas along the river (Solo-Gabrielle, 1995).

Priorities

Based on the review of the available water quality and other information, the following priority actions are recommended for the subbasin:

1. Identify and control major sources of bacteria loadings to the Aberjona.

It has long been known that the Aberjona is contaminated with sewage bacteria. Development and implementation of a TMDL is needed to control sewage inputs to the river. High levels of *Enterococcus* are present in the river during wet weather and dry weather, suggesting that a two-part strategy may be necessary to identify the major sources of bacteria pollution. During dry weather, stormwater pipes that are actively discharging “dry-weather baseflow” should be sampled and analyzed for the presence of sewage bacteria. If pipe discharge is not found to be the major source, then the river should be analyzed in sections (reaches) to identify contaminated groundwater discharge areas, and tributary streams and brooks should be investigated to identify contaminated surface water inputs. A similar methodology should be adopted for identifying “hotspots” during wet weather. Ideally, sampling should be done before, during, and after peak wet-weather flows at a given pipe or river site to identify the sources of stormwater bacterial loadings.

2. Identify and control major sources of unionized ammonia (NH_3) loadings to the Aberjona.

A TMDL should also be developed for NH_3 in the river. A hotspot identification strategy similar to the one outlined above for bacteria could be used. It is possible that bacteria and NH_3 derive from the same sources (e.g., sewage); therefore, some economy may be achieved by sampling for both parameters simultaneously.

3. Add “metals” to the §303d list as a cause of water quality impairment.

There is evidence that arsenic and other metals are being transported in significant amounts by the Aberjona River. Therefore, it is recommended that this evidence (e.g., Aurilio et al., 1996; Solo-Gabrielle, 1995; Davis et al., 1994; EPA, 2002) be carefully studied by the MA-DEP to determine whether the river and contaminated ponds and lakes in the subbasin – Halls Brook

[9] The EPA study is currently available for public comment and was not analyzed as part of this report.

Holding Area Pond, in particular – should be on the §303d list as being impaired with metals. If it is determined that waterbodies in the subbasin should be listed for metals impairment, then a TMDL should developed in a timely manner to limit further impacts to receiving waters. The results of EPA's current risk assessment of the Aberjona, associated with the two Superfund sites, were not available in time for this assessment report, but should provide important information on the need for a metals 303(d) listing and TMDL.

In addition to these priority actions for improving water quality in the subbasin, three actions are recommended based on the preliminary sediment quality assessment: (1) the available sediment data should be compiled into a single database; (2) the database should then be assessed with respect to appropriate sediment quality guidelines (e.g., those used in USGS, 2002); and (3) based on the assessment, actions should be proposed for addressing priority sediment contamination issues.

4.3.2 Horn Pond Subbasin

The quality of the well water from the Horn Pond aquifer is generally excellent (Chute, 1999). In contrast, the surface water in the pond itself is on the §303d list for being impaired with nutrients, organic enrichment/low DO, and noxious aquatic plants (Table 4-2). Wedge Pond is on the §303d list as being impaired by nutrients and noxious aquatic plants (Table 4-2). Whitman and Howard (1988, 1986) performed limnological studies on both ponds and reported that the low DO levels and excessive plant growth were symptomatic of high nutrient loadings from the watershed. Limited monitoring data also suggest that bacteria pollution is a problem in this subbasin.

Pollutant Sources

With the exception of nutrients in Horn Pond and Wedge Pond, there is no evidence of significant water pollution in this subbasin, although monitoring has been limited and sediments may be contaminated. There are no NPDES-permitted wastewater dischargers in the subbasin. Although there are 20 hazardous waste disposal sites (Appendix D), only one site (H10), a former oil storage area, is listed in the Tier 1A category. The majority of the other sites are contaminated with small amounts of petroleum hydrocarbons. The subbasin is relatively developed, particularly around Wedge Pond; therefore, it is likely that urban runoff is a significant source of nutrients and other materials – sand, roadsalt, suspended solids – to the ponds. Tannery waste is a historical source of pollutants to Wedge Pond, having been discharged to Russell Brook, a tributary to Horn Pond Brook in Winchester (now a buried culvert). Between 1870 and 1930, nearly 25 tanneries were in business along the brook in Woburn and north Winchester. Tanneries use metals for tanning animal hides and for coloring and providing texture to finished leather (Durant et al., 1990). It is possible that tannery wastes may have contributed to the high levels of metals detected in the sediment cores from the pond.

Water Quality Assessment

Table 4.4 summarizes the limited available water quality results for the Horn Pond subbasin.

Table 4.4 Summary of Horn Pond Water Quality Results

Parameter	Standard	1980-1981 (4 sites) No. of Samples	Percent Exceeding Standard
Fecal coliform	Class B >200 cfu/100 ML	14	64%
Fecal coliform	Class C > 1000 cfu/100 ML	14	22%
Enterococcus	>33 cfu/ML	0	-
E. Coli	>126 cfu/100ML	0	-
Dissolved Oxygen	<5 mg/L	14	0%
Dissolved Oxygen Saturation	<60+ %	7	14%
Dissolved Oxygen Sat. Calculated	<60%	0	-
Temperature	>28.3^{o}C	14	0%
pH	<6.5 or >8.3	135	5%
Total Suspended Solids (TSS)	>10 mg/L	0	-
Total Nitrogen	>0.3 mg/L	0	-
Total Phosphorous	>0.05 mg/L	14	93%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Relatively little information exists on water quality in the Horn Pond subbasin. As shown in Table 4-4, only four sites have been monitored, and the last time was in 1981. The results in Table 4-4 indicate that, with the exception of fecal coliform bacteria and total phosphorus, the water quality parameters were within acceptable limits for Class B waters. Relatively high levels of fecal coliforms (>1,000 cfu/100mL) were observed in some of the samples, and in all of the samples total phosphorus levels exceeded 0.05 mg/L. No data were found on hazardous chemicals (e.g., toxic metals, pesticides, hydrocarbons, solvents or other organic compounds) in surface waters.

Sediment Quality

Some effort has been made to characterize the sediments in Horn Pond and Wedge Pond. Knox (1991) collected shoreline surface sediment grab samples as well as sediment cores from Horn Pond, and analyzed the samples for toxic elements, including arsenic, chromium, copper, lead, cadmium, zinc and nickel. With the exception of the levels of lead, which were somewhat elevated in the sediment core, the concentrations of these elements in the sediments were not significantly different than regional background levels. Both Knox (1991) and Durant (1993) analyzed sediment core samples from Wedge Pond and reported that the levels of arsenic, lead, chromium, zinc, and copper were significantly elevated, particularly in the deeper sediment layers. Durant (1993) also reported that sediments in the deepest parts of the pond contained elevated levels of polycyclic aromatic hydrocarbons (as much as 10-fold higher than background).

Priorities

Based the available water quality data and other information that was reviewed for the subbasin, two priorities were identified:

1. Identify and control major sources of nutrients in Wedge Pond and Horn Pond.
A nutrient TMDL should be developed and implemented for this subbasin. As part of that effort, nutrient loading from major point sources as well as nonpoint sources should be quantified, including from the sediments of the two ponds. If the internal loading from pond sediments is a significant fraction of the total, then it may be necessary to implement measures to reduce the internal loading (e.g., by adding alum).

2. Conduct additional water quality sampling in Wedge Pond and Horn Pond.
Water quality in Horn Pond, Wedge Pond and their major tributaries has not been routinely assessed for many years. A program of regular monitoring (e.g., quarterly or semi-annual) is recommended to fill this data gap. Since Horn Pond and Wedge Pond are used for recreation, it would be particularly useful to assess bacteria levels in these waters. In addition, sampling of these ponds should be done as part of implementing the recommended bacteria TMDL for the Aberjona River.

4.3.3 Mystic Lakes Subbasin

Pollutant Sources

Although the lakes are not on the §303d list of impaired waterways, there are several known and suspected sources that contribute pollutants to the lakes. Upper Mystic Lake is the receiving water for the Aberjona River, which is on the §303d list for unionized ammonia (NH_3), organic enrichment/low DO and pathogens (Table 4-2). The Aberjona also contributes loadings of pesticides, volatile organic compounds, and toxic elements (e.g., arsenic, chromium, lead) to the upper lake (http://water.usgs.gov/, accessed May 2003; Solo, 1995). The sediments of both lakes, particularly Upper Mystic Lake, contain significantly elevated levels of lead, arsenic, chromium and other toxic elements which were released by chemical manufacturing and leather tanning companies on the Aberjona watershed (Knox, 1991; Spliethoff and Hemond, 1996). Under certain conditions, sedimentary metals may be remobilized into the water column. Sewage bacteria are also entering the lakes from several sources: a stormwater pipe in Winchester was issued a §308 information request related to discharge of sewage to Upper Mystic Lake (see Appendix F); Winchester has an NPDES permit to operate a CSO on the Upper Mystic (Appendix E); and Mill Brook appears to be a source of sewage bacteria loadings to

Lower Mystic Lake. It is suspected, but not proven, that Herb Meyer Brook, which drains the Winchester Country Club golf course, may be a source of nutrient loadings to Upper Mystic Lake.

Water Quality Assessment

Table 4.5 summarizes the available water quality results for the Mystic Lakes subbasin.

Table 4.5: Summary of Mystic Lakes Water Quality Results

		1967-1997 (2 sites)		1998-2002 (2 sites)		Total Period 1967-2002 (2 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Fecal coliform	Class B >200 cfu/100 ML	56	7%	70	26%	126	18%
Fecal coliform	Class C > 1000 cfu/100 ML	56	2%	70	6%	126	4%
Enterococcus	>33 cfu/ML	0	-	61	23%	61	23%
E. Coli	>126 cfu/100ML	0	-	0	-	0	-
Dissolved Oxygen	<5 mg/L	64	0%	20	0%	84	0%
Dissolved Oxygen Saturation	<60+ %	0	-	20	0%	20	0%
Dissolved Oxygen Sat. Calculated	<60%	0	-	30	0%	30	0%
Temperature	>28.3^{o}C	63	0%	19	0%	82	0%
pH	<6.5 or >8.3	38	6%	17	12%	55	8%
Total Suspended Solids (TSS)	>10 mg/L	0	-	18	0%	18	0%
Total Nitrogen	>0.3 mg/L	0	-	0	-	0	-
Total Phosphorous	>0.05 mg/L	81	58%	17	6%	98	49%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Since the 1970s, water quality data have been collected at two sites on Upper Mystic Lake: Sandy Beach and the lake outlet. A summary of the last five years of water quality data in Table 4-5 indicates that water quality is generally good at the two sites, but about 25% of the samples collected from Sandy Beach exceeded the swimming standards for fecal coliform and *Enterococcus* bacteria. (Note: the beach was closed for 3 weeks during the summer of 2002 due to bacterial contamination (M. Doolittle, MDC, Boston, personal communication, 2003).) A large fraction of the samples (particularly those from before 1998) from both sites were also above the guideline limit of 0.05 mg/L used in this report for total phosphorus. No sites on Lower Mystic Lake have been regularly monitored for water quality. As in the Aberjona subbasin, fecal coliform exceedances are somewhat worse and Total Phosphorous exceedances are somewhat less common in recent years than in the earlier period.

Sediment Quality

Spliethoff and Hemond (1996) showed that the sediments of Upper Mystic Lake contain very high levels of toxic elements, including arsenic, chromium and lead. While the maximum concentrations of these elements (>2,000 ppm) are in excess of the action levels for soil, the most contaminated sediments appear to be deeply buried in areas far removed from human contact. Sedimentary arsenic can dissolve into the water column under anoxic conditions; thus, concerns have been raised that remobilized arsenic could pose a risk to recreational boaters and swimmers. However, research by Aurilio et al. (1994) and Spliethoff et al. (1995) has shown that arsenic levels in the lake, particularly near the lake surface, are very low (i.e., <2 ug/L on average). Senn and Hemond (2002) have demonstrated that arsenic remobilization from the sediments is controlled – even during long periods of anoxia in the summer – by high levels of nitrate in the lake water.

The sediments of Lower Mystic Lake are also contaminated with arsenic, chromium and lead, but the maximum levels appear to be much lower than in Upper Mystic Lake (Knox, 1991). Arsenic levels in the water column of the Lower Mystic Lake are generally higher than in the Upper Mystic (Aurilio et al., 1994). This may be attributable to the salty water layer at the bottom of Lower Mystic and other chemical differences between the two lakes. Mercury levels also appear to be elevated in the bottom waters of the Lower Mystic. Mercury is a concern because it tends to bioaccumulate in fish; however, fish collected from the lake appear to be within in the accepted limit of 0.5 µg/g (MA-DEP, 2002b).

Priorities

Based on the available water quality data and information for the subbasin, particularly the two lakes, a major priority is to identify and control the sources of bacteria that are impacting Sandy Beach.

1. Identify and control major source(s) of sewage bacteria loadings to Sandy Beach.
A plan of study should be developed and carried out to identify the sources of bacteria to the beach area. The list of potential sources includes the Aberjona River (which is on the §303d list for pathogens), stormwater pipes that discharge into the lake, leaky sewage pipes, and the beach sediments. Data from the EMPACT project analysis performed at Tufts University indicate that the majority of bacterial exceedences are associated with rainstorms

(http://www.mysticriveronline.org, accessed May 2003); therefore, stormwater sampling should be a major component of the source identification strategy.

4.3.4 Mill Brook Subbasin

Pollutant Sources

Mill Brook is not on the §303d list of impaired waterbodies, and with the significant exception of sewage bacteria, there is no current evidence that the brook is impaired by pollutants. As shown in Appendix D, there are seventeen hazardous waste disposal sites in the subbasin. However, most of the releases are relatively small and the waste chemicals have been contained on site. There is one minor NPDES-permitted discharger of wastewater in the subbasin (Appendix E).

Water Quality Assessment

Table 4.6 summarizes the available water quality results for the Mill Brook subbasin.

Table 4.6: Summary of Mill Brook Water Quality Results

		1967-1997 (5 sites)		1998-2002 (2 sites)		Total Period 1967-2002 (7 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Fecal coliform	Class B >200 cfu/100 ML	43	37%	30	97%	73	61%
Fecal coliform	Class C > 1000 cfu/100 ML	43	19%	30	63%	73	37%
Enterococcus	>33 cfu/ML	0	-	0	-	0	-
E. Coli	>126 cfu/100ML	0	-	8	100%	8	100%
Dissolved Oxygen	<5 mg/L	109	4%	29	0%	138	3%
Dissolved Oxygen Saturation	<60+ %	0	-	20	10%	20	10%
Dissolved Oxygen Sat. Calculated	<60%	0	-	42	7%	42	7%
Temperature	>28.3°C	108	0%	29	0%	137	0%
pH	<6.5 or >8.3	69	7%	30	3%	99	6%
Total Suspended Solids (TSS)	>10 mg/L	0	-	20	35%	20	35%

Table 4.6: Summary of Mill Brook Water Quality Results

Parameter	Standard	1967-1997 (5 sites)		1998-2002 (2 sites)		Total Period 1967-2002 (7 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
Total Nitrogen	>0.3 mg/L	0	-	10	100%	10	100%
Total Phosphorous	>0.05 mg/L	116	83%	29	72%	145	81%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Relatively few water quality data are available for Mill Brook. As shown in Table 4-6 and Appendix C, only one site (MIL0.062) on the brook is currently being monitored. This site was first monitored in 1999 by the USGS. It is now being monitored on a monthly basis by the Mystic River Watershed Association's Mystic Monitoring Network program. One other site was monitored in 1999-2000. Before 1999, four other sites were monitored on the brook, but the last time they were monitored was in 1981. According to the detailed data reported in Appendix C, the lower portion of the brook (just upstream of Lower Mystic Lake) is significantly impacted by sewage bacteria and nutrients. Between 1999 and 2002, thirty samples were collected at MIL0.062 and all but one exceeded the swimming standard for fecal coliform bacteria (200 cfu/100 mL) and 70% exceeded the boating standard (1,000 cfu/100 mL). The majority of these samples were collected during dry weather, which strongly suggests that improper discharges of sewage were the source of the bacteria. In addition, all of the samples exceeded the total nitrogen guideline and 72% exceeded the total phosphorus guideline used in this report. It is likely that the nitrogen and phosphorous also derived from sewage inputs to the brook.

Sediment Quality

Only one study was found that describes the sediment quality in Mill Brook. Ivushkina (1998) collected samples from 14 quiescent areas along the open (unculverted) sections of the brook – from Lower Mystic Lake to Great Meadows in Lexington. The samples were relatively free of toxic metals (e.g., lead, chromium, copper, zinc) and arsenic; however, the samples only contained small amounts of organic-rich, fine-grained sedimentary material that typically has a high affinity for metals. The relatively low amount of contaminated sediment in the brook is likely attributable to sediment scour rather than a lack of historic sources of contamination in the watershed. Background levels of metals in the sediments of urban ponds, lakes and depositional areas along rivers are typically higher than those found on Mill Brook.

Priorities
The most significant water quality problems in the brook are due to inputs of raw sewage; therefore, a priority for the subbasin is to identify and control the sources of sewage entering the brook.

1. Identify and control major source(s) of bacteria loadings to Mill Brook.
Because much of the sewage entering the brook appears to derive from dry-weather discharge, areas contributing to specific problem pipes should be investigated for cross-connections, illegal connections and inflow & infiltration (I&I) problems.

4.3.5 Mystic River 1 Subbasin

Pollutant Sources
Mystic River 1 is on the §303d list for nutrients, metals, and pathogens (Table 4-2). The sources of these pollutants have not been determined; however, due to the very urban character of this subbasin, it is likely that multiple sources are responsible. The majority of the pathogens derive from CSO and sanitary sewer discharges and from stormwater runoff released either directly to the Mystic or to its tributaries. There are seven active CSOs on the Alewife Brook. Treated stormwater is also occasionally released to Mystic River 1 from the Somerville Marginal treatment plant near Assembly Square. In addition, Arlington, Belmont, Cambridge, Medford, and Somerville have all received §308 letters requesting information on sanitary sewage discharges from stormwater pipes (see Appendix F). Nutrients (particularly certain forms of nitrogen) are also commonly found in sewage; phosphorus and various metals (e.g., zinc) are typically present in urban stormwater runoff. Because of the Amelia Earhart dam, the river is poorly flushed, and this has led to sediment accumulation along much of the length of the river. It is likely that the sediments are a source of nutrients and metals to the water column.

Another source of pollutants to the Mystic River is permitted discharges of wastewater. Including the CSO in Somerville, there are 10 NPDES-permitted wastewater discharges in the subbasin, and three known unpermitted discharges (Appendix E). Direct releases of hazardous chemical wastes are not known to be a problem in the subbasin. While there are 45 hazardous wastes sites in the subbasin that are currently under investigation by MA DEP (Appendix D), no evidence is available that indicates that chemicals from these sites have leached into the river.

Water Quality Assessment

Table 4.7 summarizes the available water quality results for the Mystic River 1 subbasin.

Table 4.7: Summary of Mystic River 1 Water Quality Results

Parameter	Standard	1967-1997 (21 sites)		1998-2002 (10 sites)		Total Period 1967-2002 (22 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
Fecal coliform	Class B >200 cfu/100 ML	955	42%	1,019	38%	1,974	39%
Fecal coliform	Class C > 1000 cfu/100 ML	955	12%	1,019	10%	1,974	11%
Enterococcus	>33 cfu/ML	0	-	960	46%	960	46%
E. Coli	>126 cfu/100ML	0	-	9	44%	9	44%
Dissolved Oxygen	<5 mg/L	992	2%	891	10%	1,883	6%
Dissolved Oxygen Saturation	<60+ %	0	-	880	12%	0	-
Dissolved Oxygen Sat. Calculated	<60%	0	-	880	12%	880	12%
Temperature	>28.3^{o}C	1.021	0%	895	0%	1,916	0%
pH	<6.5 or >8.3	269	29%	781	19%	1,050	22%
Total Suspended Solids (TSS)	>10 mg/L			431	23%	431	23%
Total Nitrogen	>0.3 mg/L	95	98%	397	100%	492	100%
Total Phosphorous	>0.05 mg/L	285	6%	436	68%	721	68%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Of all the subbasins in the Mystic Watershed, Mystic River 1 has received the most attention in terms of water quality monitoring. The oldest records are from a Massachusetts Water Resources Commission study in 1967. Since then, this section of the Mystic has been studied by several state and federal agencies as well as Tufts University. In all, a total of 22 sites have been monitored (see Table 4-7). According to the summaries in Tables 4-7 for the entire period of record (1967-2002), the water quality standards and guidelines for sewage indicator bacteria, nutrients and TSS are exceeded in a high percentage of the samples at many sites along the river. There is no evidence that water quality in the river has substantially improved (or worsened) in the last 5 years as compared to earlier years. The data in Table 4-7 are consistent with Mystic River 1 being on the §303(d) list for nutrient and pathogen impairment.

Sediment Quality
Relatively few historical sediment quality data are available for this subbasin. In the one study that was found (Downs, 1999), data from surface sediment grab samples collected in the river do not indicate significant contamination. Although, the levels of metals – e.g., arsenic, chromium, lead, and zinc – are elevated with respect to background, they are within the range that is typical of urban waterbodies. A study that included sediment core sample collection at the Amelia Earhart Dam was performed in 2002 by the USGS; however, the results of the study have not yet been published (Rob Breault, USGS, Marlboro, MA; personal communication, 2003).

Priorities
In terms of water quality, the most important priorities for the subbasin are to identify and control the major sources of bacteria, nutrients, and metals to the river. Another priority is to control the growth of nuisance aquatic weeds in Bellevue Pond in Medford.

1. Identify and control major source(s) of bacteria, nutrients, and metals to Mystic River.
Due to the multiplicity of pollutant inputs in this subbasin, it is reasonable to suggest that these three classes of pollutants may derive from the same general sources. In particular, it is likely that CSO discharges to the Alewife Brook and stormwater runoff are major contributors of bacteria, nutrients, and metals to the river. Therefore, considerable economies would be gained by developing a monitoring and implementation strategy to target all three classes of pollutants simultaneously.

2. Control the growth of aquatic weeds in Bellevue Pond
Because funding is not generally available at the state level for aquatic weed control, the City of Medford should be encouraged to fund a weed control effort in the pond.

4.3.6 Alewife Brook Subbasin

Pollutant Sources
Three waterbodies in the subbasin – Alewife Brook, Spy Pond, and Clay Pit Pond – are listed as impaired on the §303(d) list (Table 4-2). The Alewife is listed for pathogens, the known sources of which include CSOs, dry- and wet-weather discharges from sanitary sewer pipes, and stormwater runoff (which typically contains fecal material from diverse, nonhuman sources such as dogs, birds, and other warm-blooded animals). While the fraction of the total pathogen loading attributable to each of these sources is not known, loadings are expected to decrease in the future. Recent modifications to the CSOs by the City of Cambridge and the MWRA are predicted to reduce the number and volume of discharges per year. Also, Clean Water Act §308

notices have been issued to Cambridge, Belmont, Somerville, and Arlington, which, if complied with, should lead to reductions of sanitary sewage discharges (see Appendix F).

Spy Pond is on the §303(d) list as impaired for nutrients, organic enrichment/low DO, and noxious aquatic plants. The pond contains a north and south basin, which are separated by a shallow sill. Water quality in the south basin is generally poorer than in the north, in large part because the south basin receives considerable inputs of runoff from the Route 2 drainage area. It is also relatively shallow. High nutrient loadings and ample light penetration in the south basin have promoted the growth of substantial macrophyte populations, which in turn exacerbate the problems of organic enrichment/low DO. In addition to these problems, high levels of arsenic are present in the pond sediments. The arsenic appears to be the result of herbicide applications in the 1960s (Durant et al., 2003).

Clay Pit Pond is on the §303(d) list as impaired for pesticides. The pond sediment contains high levels of chlordane, and as a result warnings have been posted to alert anglers to the potential risks associated with eating the fish (MA-DPH, 2002).

Fish tissue testing was recently conducted for Spy Pond, in response to a community request. The Pond has been issued a fish consumption advisory for chlordane as a result.

Other known sources of pollutants in the subbasin include wastewater dischargers (other than CSOs) and hazardous waste disposal sites. As shown in Appendix E, there are seven NPDES-permitted dischargers in the subbasin and three more that are as yet unpermitted. There are 35 known hazardous waste disposal sites in subbasin (Appendix D); however, none are Tier IA sites.

Water Quality Assessment

Table 4.8 summarizes the available water quality results for the Alewife Brook subbasin.

Table 4.8: Summary of Alewife Brook Water Quality Results

		1973-1997 (17 sites)		1998-2002 (11 sites)		Total Period 1973-2002 (18 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Fecal coliform	Class B >200 cfu/100 ML	261	75%	576	93%	837	87%
Fecal coliform	Class C > 1000 cfu/100 ML	261	45%	576	59%	837	55%
Enterococcus	>33 cfu/ML	198	89%	450	96%	648	94%
E. Coli	>126 cfu/100ML			105	99%	105	99%

Table 4.8: Summary of Alewife Brook Water Quality Results							
		1973-1997 (17 sites)		1998-2002 (11 sites)		Total Period 1973-2002 (18 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Dissolved Oxygen	<5 mg/L	255	46%	85	25%	340	40%
Dissolved Oxygen Saturation	<60+ %	0	-	73	38%	73	38%
Dissolved Oxygen Sat. Calculated	<60%	0	-	111	37%	111	37%
Temperature	>28.3^{o}C	257	0%	93	0%	350	0%
pH	<6.5 or >8.3	74	8%	49	2%	123	6%
Total Suspended Solids (TSS)	>10 mg/L	36	9%	40	23%	76	16%
Total Nitrogen	>0.3 mg/L	12	83%	12	100%	24	92%
Total Phosphorous	>0.05 mg/L	197	37%	47	98%	244	49%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Compared to other subbasins of the Mystic, a considerable amount of effort has been invested in monitoring water quality in the Alewife. As shown in Table 4-8 and Appendix C, records go back to 1973 when two sites were monitored on Alewife Brook. Since then an additional 16 sites in the subbasin have been monitored at least once. Summaries of the results in Table 4-8 indicate that bacteria levels consistently exceed Class B and Class C water quality standards at most of the monitoring sites. The summaries also indicate that DO levels are typically low at most sites. This may indicate organic enrichment caused by anthropogenic inputs. In addition, the summaries suggest that total nitrogen and phosphorus levels are consistently elevated at many of the sites.

Sediment Quality

Two studies have been conducted to determine the amounts and distribution of organic and inorganic pollutants in sediments samples collected from the subbasin. O'Shea and Kennedy (1989) collected sediments from 13 sites along Alewife Brook and Little Brook, and analyzed the samples for a suite of toxic elements (arsenic, chromium, copper, mercury, nickel, lead and zinc), polycyclic aromatic compounds (PAH) and polychlorinated biphenyls (PCBs). Their results indicate that several of the sediments, particularly those collected downstream of CSOs, were moderately contaminated with metals and PAHs. PCBs were also detected at parts per million levels at two of the sites. Ivushkina (1999) also collected sediment samples from along the main stem of the Alewife and Little Brooks, as well as from Little Pond and Spy Pond. The samples were analyzed for a broad suite of elements. Ivushkina's results were similar to those of O'Shea and Kennedy, indicating moderate metals contamination in the sediments, particularly in samples collected below Broadway Avenue. The sample from Little Pond was free of significant contamination; however, the samples from Spy Pond were found to contain significantly elevated levels of arsenic. Sediments from Little Pond and Spy Pond have not been analyzed for organic pollutants. The sediments in Clay Pit Pond in Belmont are contaminated with chlordane, an organic pesticide (MA-DPH, 2002).

Priorities

In this subbasin, the most important water quality priority is to identify and control the major sources of sewage bacteria (pathogens) entering the Alewife Brook. The water quality classification for the brook is currently subject to a "variance", pending a decision about the extent to which CSOs will be reduced or eliminated. In addition, priority actions are recommended for Spy Pond. Although Clay Pit Pond is contaminated with chlordane, the contamination appears to be most highly concentrated in the sediments and fish tissue. Because swimming is not allowed and the state Department of Public Health has issued a fishing advisory, the chlordane does not appear to be an imminent public health threat, and it is likely that the chlordane came from past pesticide use. No priority actions are recommended for Clay Pit Pond, although general efforts to discourage pesticide use near surface waters are warranted throughout the watershed, as part of general stormwater education efforts.

1. Identify major sources of sewage bacteria to Alewife Brook

Although there are just two major sources of bacteria entering the Alewife Brook/Little Brook system – sanitary sewers and nonpoint sources – it is useful to distinguish three distinct sources: dry-weather discharges from stormwater pipes, wet-weather discharges from stormwater pipes, and CSO discharges. Dry-weather discharges, which are typically due to connections between sanitary sewage and stormwater pipes, are illegal and are regulated under the Clean Water Act. Sewage bacteria that derive from the watershed (e.g., animal waste) and that enters the brook during wet-weather are regulated under Phase I/II of the NPDES stormwater regulations. Sewage discharges from CSOs are regulated by NPDES permitting process.

2. Add organic enrichment/low DO and nutrients for §303d list for Alewife

Based on the number of times that DO in Alewife Brook has been measured at levels below the water quality standard, it is recommended that organic enrichment/low DO be added to the §303(d) list for the brook.

3. Control nutrients entering Spy Pond.

While the growth of aquatic weeds in Spy Pond can be controlled through short-term measures such as chemical treatment and mechanical harvesting, the solution for the long-term is to minimize inputs of nutrients, particularly phosphorus, to the pond. Gawel et al. (2000) estimated that 250-510 kg/yr of phosphorus enters the pond in surface water inflows. As much as half of this enters the pond through the Route 2 storm drain. Because it is infeasible to use end of pipe controls on the Route 2 drain pipe, the most practical approach to reducing phosphorus is to employ best management practices (BMPs) on the Spy Pond watershed. Funding for structural

BMPs has been obtained by the Town of Arlington from a §319 grant. The town previously received funding from the Department of Environmental Management's Ponds and Lakes Program to control the internal loading of phosphorus from the pond sediments, as well as loadings from the portion of the watershed on the opposite side of the pond from the Route 2 storm drain.

4.3.7 Malden River Subbasin

Pollutant Sources

Two waterbodies in this subbasin are on the §303(d) list (Table 4-2): Ell Pond is listed for nutrients, suspended solids, and pathogens, and the Malden River is listed for organic enrichment/low DO, pathogens and suspended solids. Relatively little work has been done to identify the sources of pollutants to these waterbodies. The evidence suggests that the Malden River has received and is continuing to receive inputs of pollutants from diverse urban and industrial sources such as stormwater, sanitary sewers, and hazardous waste disposal sites. Because the subbasin has a very high percentage of developed land (69%), much of which is impervious, stormwater runoff and its associated pollutants (e.g., particles, fecal bacteria, nutrients) enter the river at high rates. Although there are no permitted CSOs on the Malden, pipes have been identified that carry high levels of sewage bacteria during dry weather (R. Frymire, personal communication, 2002). This strongly suggests the presence of illegal connections between sanitary and storm sewers. In addition to stormwater and discharges from pipes during dry weather, there are also four companies in the subbasin that have NPDES permits to discharge wastewater to the Malden (Appendix E). Two other companies that discharge wastewater to the Malden have to be issued NPDES permits. Another category of inputs that may be significant, particularly south of Malden Square, is chemicals leaching from soil and groundwater at hazardous waste disposal sites. As shown in Appendix D, there are 58 known hazardous waste disposal sites in the subbasin, and of these ten are located on riverfront properties. For example, at the Wellington Realty site, a former chemical manufacturing site that abuts Little Creek (D50), pure phase coal tar and high levels of arsenic and cyanide have been found in the subsurface (Norwood Engineering Co., 1988).

Water Quality Assessment

Table 4.9 summarizes the available water quality results for the Malden River subbasin.

Table 4.9: Summary of Malden River Water Quality Results

		1967-1997 (2 sites)		1998-2002 (1 site)		Total Period 1967-2002 (2 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Fecal coliform	Class B >200 cfu/100 ML	35	55%	18	61%	53	57%
Fecal	Class C	35	31%	18	22%	53	28%

Table 4.9: Summary of Malden River Water Quality Results							
		1967-1997 (2 sites)		1998-2002 (1 site)		Total Period 1967-2002 (2 sites)	
Parameter	Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
coliform	> 1000 cfu/100 ML						
Enterococcus	>33 cfu/ML	0	-	0	-	0	-
E. Coli	>126 cfu/100ML	0	-	0	-	0	-
Dissolved Oxygen	<5 mg/L	41	3%	19	0%	60	2%
Dissolved Oxygen Saturation	<60+ %	0	-	19	21%	19	21%
Dissolved Oxygen Sat. Calculated	<60%	0	-	32	19%	32	19%
Temperature	>28.3^{o}C	41	2%	20	5%	61	3%
pH	<6.5 or >8.3	48	4%	16	6%	64	5%
Total Suspended Solids (TSS)	>10 mg/L	0	-	19	5%	19	5%
Total Nitrogen	>0.3 mg/L	0	-	0	-	0	-
Total Phosphorous	>0.05 mg/L	50	83%	17	88%	67	84%
Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site..							

Relatively few water quality data were found for this subbasin. Only one site – the Medford St. bridge (MAL2.570w) – has been routinely monitored for sewage bacteria and standard water quality parameters. The data in Tables 4-9 and Appendix C indicate that fecal coliform levels exceed the Class B water quality standard in about half the samples and exceed the Class C standard in about 20% of the samples. The data also indicate that total phosphorus levels exceed the guideline limit of 50 ppb used in this report in 88% of the samples. There has been little change in the percent exceedances found between the earlier period and more recent years' sampling.

In addition to the data summarized in Table 4-9, another one-time study of the Malden was reviewed. In August of 1999, the Malden was investigated as part of the Telecom City Redevelopment Project (now called River's Edge) and USEPA Brownfields Pilot Grant Program (Nagle Consulting Associates, 1999). In this study, standard water quality parameters (DO, temperature, pH, TSS, conductivity, salinity) were monitored at 15 sites in Little Creek and the Malden between Medford St. and Route 16. Most of the results were within acceptable limits for Class B waters; however, the bottom waters contained very low DO, particularly at sites where thermal stratification was strongest and where salinity was highest.

Sediment Quality

There has been very little data available on sediment quality in the Malden River, until recently. Only one dataset was found, which pertained to the southern part of the river between Medford St. and Route 16 and Little Creek (Nance Consulting Associates, 1999). Surface sediment and sediment core samples were collected and analyzed for selected metals, volatile organic compounds (VOCs), phthalates, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons. The results showed that phthalates were elevated in several of the samples and that PAHs were elevated in samples collected near Little Creek. The levels of VOCs and metals were generally low, while the levels of PCBs were moderately elevated in one of the four samples analyzed for PCB content. A second sediment study of the river was performed by the USGS in the summer of 2002; however, the results have not yet been published (Rob Breault, USGS, Marlboro, MA; personal communication, 2003).

Currently, the Army Corps of Engineers is working with the Mystic Valley Development Corp. (the body responsible for the planned TeleCom City development) to assess sediments in the Malden River as part of a habitat restoration study. The results of this work were not available in time for inclusion in this report, but should provide useful new information on sediment quality in the Malden.

Priorities

In terms of water quality, there are several priorities for the Malden River subbasin. One of the highest is to identify and control inputs of pathogens into the Malden River. A second important priority is to identify and control inputs of both pathogens and nutrients into Ell Pond in Melrose.

1. Identify and control major sources of sewage bacteria loadings to the Malden River

Monitoring should be conducted to identify specific sources of pathogen loadings to the river. As part of the program, tributaries and stormwater discharge pipes should be sampled during both dry- and wet-weather to identify significant sources of pollution to the creek. If tributary streams are found to be major sources, additional investigation should be performed to identify specific sources on the tributaries.

2. Identify and control major sources of sewage bacteria and nutrient loadings to Ell Pond

It is recommended that both a pathogen and a nutrient TMDL be developed and implemented for the Ell Pond subbasin. Because it is likely that the pathogens and nutrients derive from many of the same sources (and/or source areas), some economy may be achieved by sampling for both parameters simultaneously. As part of the nutrient TMDL, an effort should be made to quantify the nutrient loadings from the pond sediments.

4.3.8 Mystic River 2 Subbasin (Amelia Earhart Dam to Charles River)

Pollutant Sources

The saltwater portion of the Mystic is on the §303(d) list as being impaired for high levels of unionized ammonia (NH_3), pathogens, oil and grease, and turbidity, and for having excessive organic enrichment and low DO (Table 4-2). The sources of these pollutants have not been identified and quantified; however, due to the nature of the land-uses in the subbasin, it is likely that multiple point and nonpoint sources are responsible. Point sources include stormwater runoff pipes and NPDES-permitted discharge pipes. There are more NPDES-permitted wastewater dischargers in this subbasin (22) than in any other in the watershed. There are three major dischargers, including the Sithe Mystic power plant, a CSO in Chelsea, and an oil terminal in Everett. Significant nonpoint sources include hazardous waste disposal sites (see Appendix D) and contaminated bottom-sediments. For example, at Island End River where there is a former coal tar processing facility (site Y20), a large amount of coal tar is buried under the river sediments and is continuing to release contaminants to the river (Stephen Spencer, MA-DEP, personal communication, 2002).

Water Quality Assessment

Table 4.10 summarizes the available water quality results for the Mystic River 2 subbasin.

Table 4.10: Summary of Mystic River 2 Water Quality Results

		1989-1997 (3 sites)		1998-2002 (4 sites)		Total Period 1989-2002 (4 sites)	
Parameter	**Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**	**No. of Samples**	**Percent Exceeding Standard**
Fecal coliform	Class B >200 cfu/100 ML	903	53%	599	22%	1,502	41%
Fecal coliform	Class C > 1000 cfu/100 ML	903	20%	599	9%	1,502	16%
Enterococcus	>33 cfu/ML	0	-	674	21%	674	21%
E. Coli	>126 cfu/100ML	0	-	0	-	0	-
Dissolved Oxygen	<5 mg/L	1,224	13%	12	0%	1,236	13%
Dissolved Oxygen Saturation	<60+ %	590	6%	12	0%	602	6%
Dissolved Oxygen Sat. Calculated	<60%	0	-	12	33%	12	33%
Temperature	>28.3°C	1,254	0%	12	0%	1,266	0%
pH	<6.5 or >8.3	0	-	0	-	0	-

Table 4.10: Summary of Mystic River 2 Water Quality Results

Parameter	Standard	1989-1997 (3 sites)		1998-2002 (4 sites)		Total Period 1989-2002 (4 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
Total Suspended Solids (TSS)	>10 mg/L			280	6%	280	6%
Total Nitrogen	>0.3 mg/L	132	99%	0	-	132	99%
Total Phosphorous	>0.05 mg/L	112	57%	0	-	112	57%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Available water quality records indicate that the Mystic River 2 subbasin has not been widely monitored. According to the data in Table 4-10 and Appendix C, only four sites in the Mystic River have been monitored since 1989. The two sites that received the most attention are MYS2.787, which is just downstream of the outfall from the Somerville Margin CSO Treatment Facility, and MYS1.407, which is just upstream of the confluence with Chelsea Creek. Fecal coliform and *Enterococcus* bacteria have been routinely monitored at both sites by the MWRA; temperature, DO, pH, TSS and nutrients have also been monitored, but much less frequently than bacteria. As shown in Appendix C, bacteria levels exceed the swimming standards in 10-37% of the samples and the boating standard in 3-16% of the samples.

Sediment Quality

Several investigators have analyzed sediment samples from sites in the subbasin (Buchholtz ten Brink et al., 2002). The results show that the sediments contain relatively high levels of PAH, PCBs, lead, chromium, copper, and zinc. In addition, effort has been spent on characterizing the sediments on Island End River, near the coal tar waste disposal site (Stephen Spencer, MA-DEP, personal communication, 2002). These sediments are highly enriched in PAH and other coal tar waste products.

Priorities

Compared to other subbasins in the watershed, relatively little environmental quality data is available for the Mystic River 2 subbasin. In addition, relatively little is known about the possible risks people may face while recreating in this section of the river. Thus, while there are some obvious data gaps that need to be filled, it is also important that more information be gathered on the recreational uses of the river. Specific recommendations are described below.

1. Continue to assess the extent of recreational contact.

The Mystic River Watershed Association (MyRWA) conducted a preliminary river use survey on the Mystic in the summer of 2003. Analysis of this survey and further survey work is needed to determine who is recreating in or near the river. Preliminary results indicate that children swim and wade in the Little Mystic Channel, and that substantial boating (including use of jet skis that results in substantial direct exposure to the water) occurs in the Mystic. These findings are discussed in more detail in Chapter 6.

2. Develop a consistent water quality monitoring program.
The preliminary results of MyRWA's river use survey suggest that more frequent and widespread monitoring is needed to assess public health risks. The current MyRWA monitoring program should be expanded to include the salt water portion of the Mystic River, or other means found to monitor this subbasin on a regular basis.

3. Perform comprehensive sediment study.
Sediment sampling data should be analyzed to assess potential exposures, when the ACOE and USGS data become available. The samples should be analyzed for a broad range of organic (e.g., PAH, PCBs, pesticides, etc.) and inorganic (e.g., lead, arsenic, mercury, cadmium, copper, etc.) pollutants.

4. Analyze fish tissue for the presence of toxic chemicals
The preliminary results of the MyRWA river use survey indicate that some fishermen and others are consuming fish caught in the lower Mystic. Fish taken from the saltwater portion of the watershed should be analyzed for chemicals that tend to bioaccumulate (e.g., PAH, PCBs, mercury, pesticides). Fish consumption advisories may need to be established by the state department of public health if pollutants are detected at unsafe levels.

5. Develop TMDLs for parameters listed on the §303(d) list
To begin the process of reducing pollutant inputs to this section of the Mystic River and its tributaries, efforts should be made to quantify loadings from important sources. An efficient way of doing this is by developing TMDLs for the causes of impairment listed in Table 4-2.

4.3.9 Chelsea Creek Subbasin

Pollutant Sources
Chelsea Creek is classified as "SB" (saltwater B) with a CSO variance. It is on the §303(d) list as impaired for NH3, organic enrichment/low DO, pathogens, oil and grease, taste, odor and color and turbidity (Table 4-2). To date, relatively little work has been done to characterize and quantify pollutant loadings from sources, which include CSOs, industrial discharges, stormwater discharges and hazardous waste disposal sites. There are two NPDES-permitted wastewater dischargers in the subbasin: a CSO in Chelsea and an oil company in East Boston (Appendix E). Both are major dischargers. In addition to point sources, it is possible that chemicals leaching from hazardous waste disposal sites in Chelsea and East Boston may entering Chelsea Creek. As shown in Appendix D, there are 36 known hazardous waste disposal sites in the subbasin. Ten of these sites are located on riverfront properties and one (C12) is classified as a Tier IA site.

Water Quality Assessment

Table 4.11 summarizes the available water quality results for the Chelsea Creek subbasin.

Table 4.11: Summary of Chelsea Creek Water Quality Results

Parameter	Standard	1989-1997 (3 sites)		1998-2002 (2 sites)		Total Period 1989-2002 (3 sites)	
		No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard	No. of Samples	Percent Exceeding Standard
Fecal coliform	Class B >200 cfu/100 ML	316	47%	9	33%	325	38%
Fecal coliform	Class C > 1000 cfu/100 ML	316	18%	9	23%	325	11%
Enterococcus	>33 cfu/ML	0	-	9	33%	9	33%
E. Coli	>126 cfu/100ML	0	11%	0	-	0	-
Dissolved Oxygen	<5 mg/L	320	10%	10	0%	330	10%
Dissolved Oxygen Saturation	<60+ %	147	-	10	0%	157	7%
Dissolved Oxygen Sat. Calculated	<60%	0	-	10	0%	10	10%
Temperature	>28.3^{o}C	327	0%	10	0%	337	0%
pH	<6.5 or >8.3	0	-	0	-	0	-
Total Suspended Solids (TSS)	>10 mg/L	64	6%	0	-	64	6%
Total Nitrogen	>0.3 mg/L	21	100%	0	-	21	100%
Total Phosphorous	>0.05 mg/L	36	78%	0	-	36	78%

Source: Tufts University Water Quality Analysis; see text and Appendix B and C for methodology and detailed results. Note that the sites sampled during each time period may not be at the same locations, and not all pollutants are analyzed at every site.

Few water quality data are available for the Chelsea Creek subbasin. As indicated in Table 4-11 and Appendix C, six sites in Chelsea Creek have been monitored, all by the MWRA; however, data were only available for three of the sites. The most recent data, from 1998 and 1999, are not sufficient to assess the quality in the river. Nonetheless, using data from sampling site CCK1.497m, which has been sampled more frequently than any other site on the river, general observations about water quality may be made. First, fecal coliform bacteria levels exceeded the primary and secondary contact standards in 30% and 12% of the samples, respectively. This is consistent with the fact that there are CSO and stormwater discharges into the creek. DO levels were generally high; levels were <5 mg/L in only 10% of the samples. In contrast, nutrient levels were elevated in a high percentage of the samples. The total nitrogen guideline used in this report was exceeded in all of the samples, while the total phosphorus guideline was exceeded in 85% of the samples.

Sediment Quality

Several investigators have analyzed sediment samples Chelsea Creek (Buchholtz ten Brink et al., 2002). The results show that the sediments contain relatively high levels of PAH, PCBs, lead and chromium. These results are not surprising, given the very urban and industrial nature of Chelsea Creek and its surrounding riverfront properties.

Priorities

Because of the scarcity of water quality data for this subbasin, a high priority is to collect data that could be used to address known and suspected causes of impairment. In addition, as was the case for the Mystic River 2 subbasin, there is little data on recreational activities that in the subbasin. For example, little is known about fish consumption habits among anglers. Such data, as well as data on other recreational activities in the subbasin, could be useful for informing the water quality data collection effort. Specific recommendations are given below.

1. Perform monthly water quality monitoring

To gain a better understanding of current water quality in the Chelsea Creek, it is recommended that routine monitoring be performed at least one site in the subbasin. Both dry- and wet-weather samples should be collected under varying tidal conditions to measure the range of conditions in the river. The parameters that should be measured include sewage indicator bacteria (*Enterococcus* is considered the most informative in saltwater), DO, NH_3, turbidity and oil and grease, all of which are on the §303(d) list.

2. Identify hotspots of pollution.

Hotspot monitoring should be conducted to help target specific areas for further detailed study. For example, tributaries (e.g., Mill Creek) and stormwater discharge pipes should be sampled during both dry- and wet-weather (and possibly at both low and high tide, depending on whether the tide greatly affects the source strength) to identify significant sources of pollution to the creek.

3. Perform a river-use survey

A river-use survey should be performed for Chelsea Creek to determine who is recreating in or near the river. The survey should be designed to identify what types of recreational activities are most common, as well as when and where they are occurring.

4. Analyze sediment and fish tissue

If it is learned through the river use study that people are being exposed to river sediments in Chelsea Creek, then sediment sampling should be done in the areas where exposure occurs. The samples should be analyzed for a broad range of organic (e.g., PAH, PCBs, pesticides, etc.) and inorganic (e.g., lead, arsenic, mercury, cadmium, copper, etc.) pollutants. Similarly, if the river use survey shows that fishermen are eating fish from the subbasin, then fish muscle samples should be analyzed for chemicals that tend to bioaccumulate (e.g., PAH, PCBs, mercury, pesticides).

4.4 Conclusions

The analysis of water and sediment quality presented in this chapter shows substantial variation in the level of assessment that has been performed in different parts of the watershed. Aberjona River, Alewife Brook and the Mystic River 1 subbasin have been extensively studied for some pollutants. More work is needed to identify specific sources of pollutants, but the major problems have been identified and action on TMDLs is needed. Monitoring of lakes and ponds (except Upper Mystic Lake) has been less extensive, and there is a severe lack of water quality monitoring data for the lower part of the watershed (Mystic River 2, Malden River and Chelsea Creek.) These data gaps need to be addressed, especially because the number of different pollutants is likely to be greater in the lower watershed. Beyond data gathering, substantial work is needed to develop TMDLs for bacteria and nutrients throughout the watershed.

In addition, a sediment strategy is needed based on analysis of the recent USGS study. Areas with highly-contaminated sediments should be assessed for exposure potential and effects on wildlife, and a strategy for remediating areas with high potential for exposure or habitat effects should be developed.

Finally, there is a serious lack of information on toxic organics and metals in the water column, except for a few extensively-studied locations like the Aberjona River Superfund sites. This is a problem given the large number of hazardous waste sites in the watershed, and the fact that the Massachusetts Contingency Plan did not include detailed assessment of impacts on adjacent waterbodies until relatively recently. The status of hazardous waste sites in the watershed should be reviewed to determine whether adequate monitoring and assessment of surface water impacts was conducted and whether realistic assumptions about potential human exposure were used, in selecting site remedies. This study should guide a strategy for selective monitoring for toxic pollutants around hazardous waste sites that have not yet been remediated or that were remediated without thorough analysis of surface water impacts. Any sites found to be potential continuing sources of pollutant loadings to the waterbodies should be subject to enforcement review and a public involvement process.

Chapter 8 identifies a number of priority tasks related to water quality issues in the watershed.